

# Assessment of DMS in Laclede County



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# Acknowledgement

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- MoDOT D-8: Earl Wallace and Andy Miller
- MoDOT HQ: Tim Chojnacki and Dan Smith
- ASTI: Pete Krikelis
- UMC: Carlos Sun
- Grad students: Reju Radhakrishnan (UMR)  
Venkat Chilukuri (UM-C)

# Outline

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- Background
- Objectives
- Methodology
- Data Collected
- Results
- Discussion

# Background



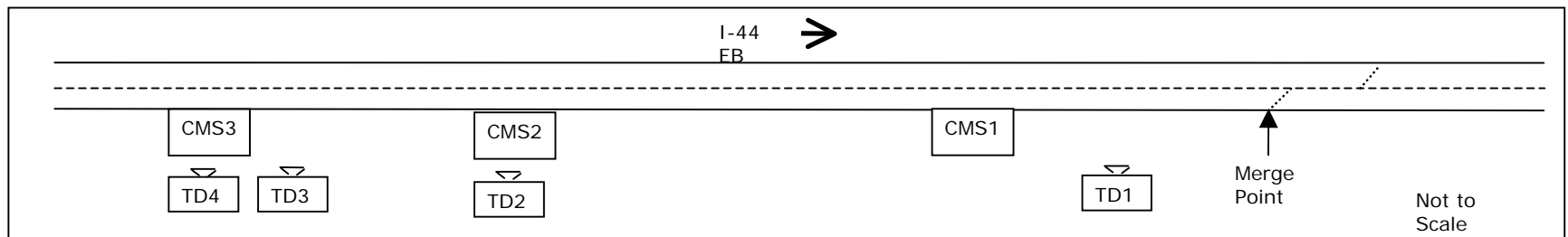
# Deployment Site

- ❑ Laclede County, Missouri
- ❑ EB I-44
- ❑ Just east of Lebanon
- ❑ Work zone: 131.413-141.081
- ❑ Crossover
- ❑ 2 lanes to 1 lane each dir.



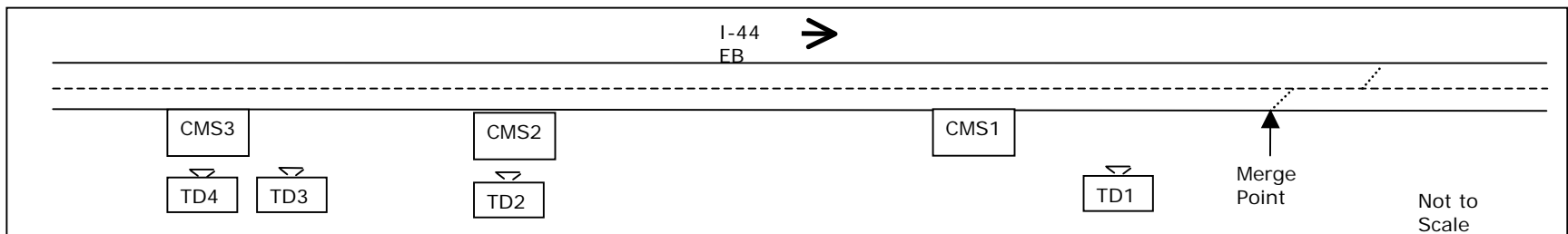
# Dynamic Late Merge System

- Changeable Message Signs (CMS) upstream from work zone
- Detectors upstream from work zone (TD)
- Automated System Manager (ASM)



# DMS Rules of Operation

Scenario	Prioritized Switching Logic	Messages		
		CMS1	CMS2	CMS3
1. Congestion	any 2 detector stations < 45 mph	MERGE HERE – TAKE TURNS	MERGE AHEAD – USE BOTH LANES	STOPPED TRAFFIC AHEAD – USE BOTH LANES
1a. Congestion + High Speed	scenario 1 and v(TD4)-v(TD1) 15 mph or v(TD3)-v(TD1) 10 mph	MERGE HERE – TAKE TURNS	REDUCE SPEED – STOPPED TRAFFIC AHEAD	REDUCE SPEED – STOPPED TRAFFIC AHEAD
2. Free Flow	any 2 detector stations > 50 mph	none	none	none
2a. Free Flow + High Speed	scenario 2 and v(TD4)-v(TD1) 15 mph or v(TD3)-v(TD1) 10 mph	none	REDUCE SPEED – ROAD WORK AHEAD	REDUCE SPEED – ROAD WORK AHEAD

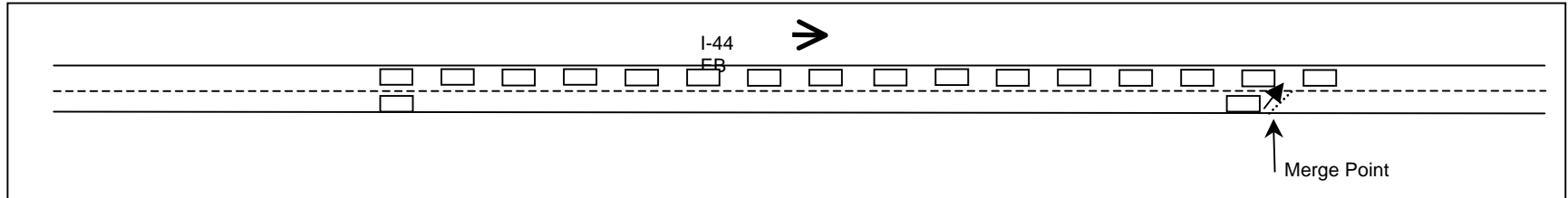


# Goals of DMS

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## □ Late Merge

- Smooth merge: reduce queue jumping



- Increase capacity: increase lane usage

## □ Speed warning

- Reduce speeding
- Decrease speed differentials



# Objectives



# Seven Evaluation Objectives

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1. Installation and Start-up
2. System Operation
3. Device Positioning
4. Traffic Info Availability and Accuracy
5. Work Zone Capacity
6. Driver Compliance
7. Safety Improvement

# Two Levels of Evaluation

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- One: evaluation of the particular system, i.e. ASTI
- Two: evaluation of DMS technology

# Before and After Study

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- Before, i.e. DMS off
  - 7/15 (Sat.) and 7/16 (Sun.)
  - All CMS's turned off entire week
- After, i.e. DMS on
  - 6/24 (Sat.) and 6/25 (Sun.)
  - Late merge and High Spd. Operation

# Methodology



# Measures of Performance

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Objective	MOE
1. Installation and start-up	MoDOT staff interview
2. System operation	a. MoDOT staff. interview b. Observation and drive through c. Confirmation of observed displays
3. Device positioning	a. MoDOT staff interview b. Observation and drive through c. Video surveillance of queue length
4. Traffic information	Comparison with POST video and radar
5. Work zone capacity	Counts and flow rates
6. Driver compliance	Discontinuous lane usage rates and % share
7. Safety	a. Speed differential between 2 lanes b. Speed variance of all vehicles c. Speed differential pre-CMS vs. post-CMS

# Data Collected



# Surveillance at Merge Point

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# Surveillance: CMS2 to CMS1

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# Speed Ground Truth

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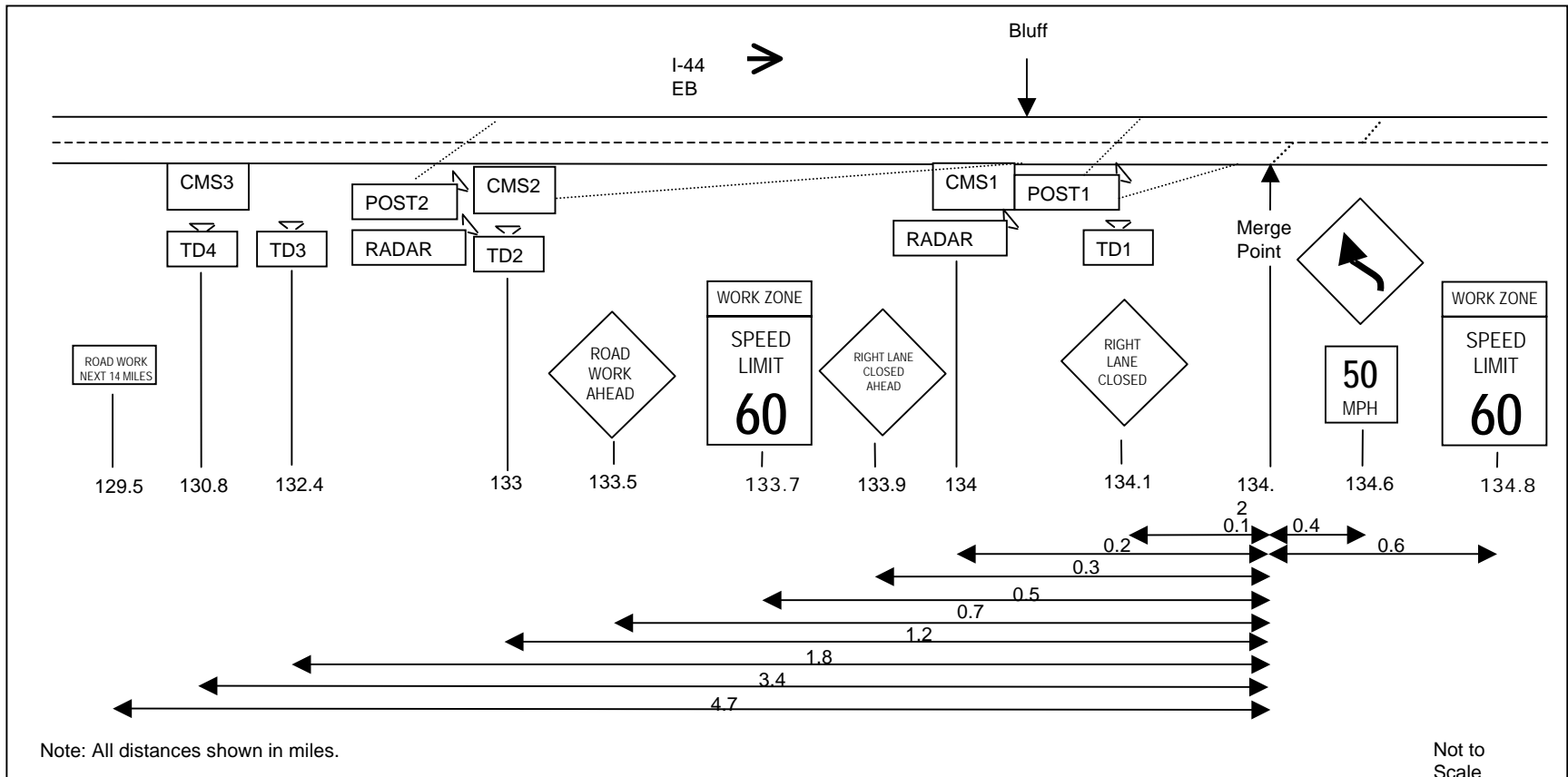


# Drive-Throughs

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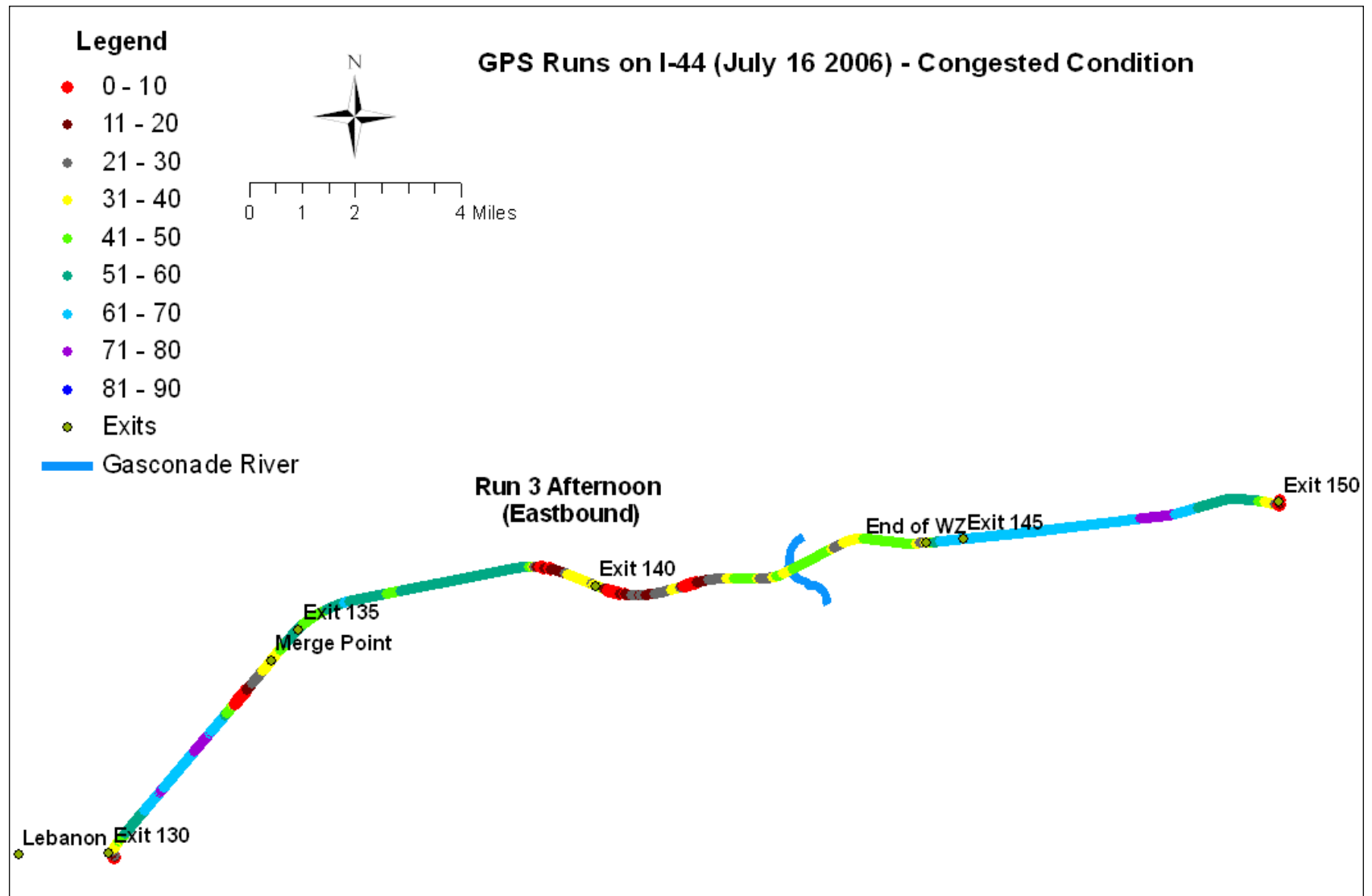


# Features of Laclede County Site

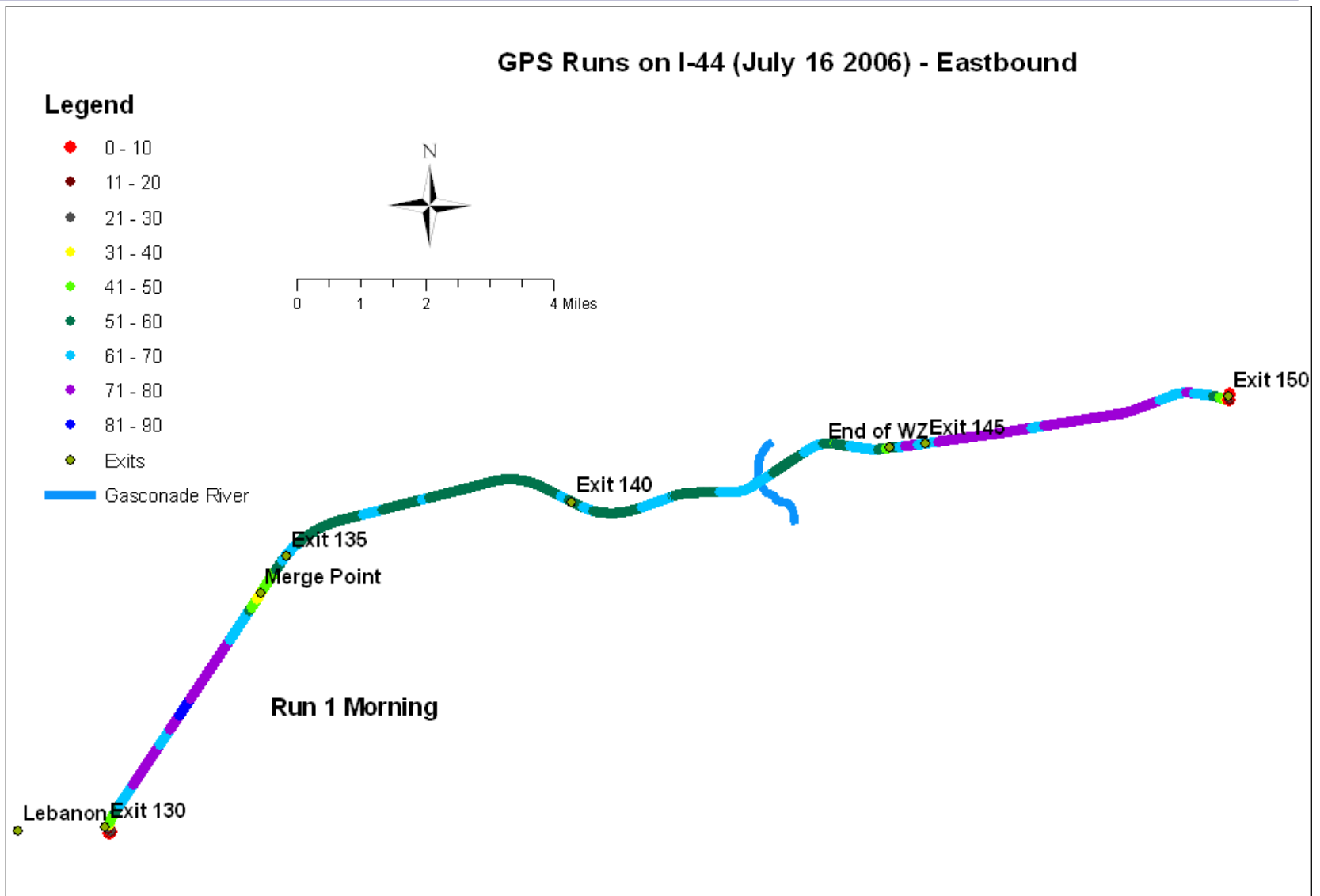




# GPS Run



# GPS Run



# Summary of Data

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- MoDOT D8 Staff Interview (8/18/06)
- Video Surveillance: 4 days, 78 hrs.
  - Before: 7/15 (Sat), 7/16 (Sun)
  - After: 6/25 (Sat), 6/26 (Sun)
  - Work zone (44 hrs.), merge pt., CMS2-CMS1
- Radar Ground Truth
- Drive-throughs, GPS run
- ASTI Detector Data: 75 days (6/7-8/20)
- Quantitative Data: Speed, Flow

# Results





# 1. Start-up and Installation

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- MoDOT D8 Staff Interview
  - System easy to deploy
  - Vendor performed well
- Challenges with geography, i.e. bluff

## 2. System Operation

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- Video verification: CMS displayed properly
- Switching logic
  - Tested logic with ASTI detector data
  - Late merge operated properly
  - Hi-spd. Problem
    - 6/24: actual 45% vs. correct 85%
    - 6/25: actual 22% vs. correct 39%
    - Improper logic or incomplete data?

### 3. Device Positioning

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- ❑ Queue growth rate not constant
- ❑ Maximum queue ~1 mi. upstream near CMS2
- ❑ Traffic re-routed by MoDOT during congestion
- ❑ Device positioning is adequate

## 4. Traffic Information

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- Accuracy (Flow, Speed, Messages)
  - Traffic flow: absolute weighted average error 34%
  - Speed: absolute weighted average error 8%
  - Side-fire detector trade-offs
  - Adequate for managing congestion
  - Inadequate for high accuracy applications
- Availability is good
  - ASTI data logging, 113 sec. period, 60 sec. data logged, 53 sec. discarded

## 5. Work Zone Capacity

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- Similar usage of discontinuous right lane (see next objective)
- Max flow:  
Before 1022 VPH, After 1213 VPH (@ merge)  
Before 1380 VPH, After 1440 VPH (within WZ)
- No significant difference in capacity

## 6. Driver Compliance

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- Discontinuous (right) lane usage
  - Before: Left 45.5% vs. Right 55.5%
  - After: Left 61.0% vs. Right 39.0%
- DMS did no increase discontinuous lane usage
- Video: no significant difference between before and after

# 7. Safety

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- Crash data not useful
- Difference in speeds? Before vs. After
  - After: Ave. 74 mph, Std. Dev. 4.6 mph
  - Before: Ave. 72 mph, Std. Dev. 4.0 mph
  - No significant change in average and variability
- Inter-lane speeds? Before vs. After
  - After - Ave. Diff.: TD4 7mph, TD3 10 mph
  - Before - Ave. Diff.: TD4 5 mph, TD3 8 mph
  - No significant change in inter-lane speeds
- No Significant change in safety

# Conclusions





# Conclusions about Objectives

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1. Installation and Start-up : Adequate
2. System Operation : Mixed
3. Device Positioning : Adequate
4. Traffic Info Avail. & Accuracy : Mixed
5. Work Zone Capacity : No change
6. Driver Compliance : No change
7. Safety Improvement : No change

# Overall Conclusion

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In general, system worked as specified

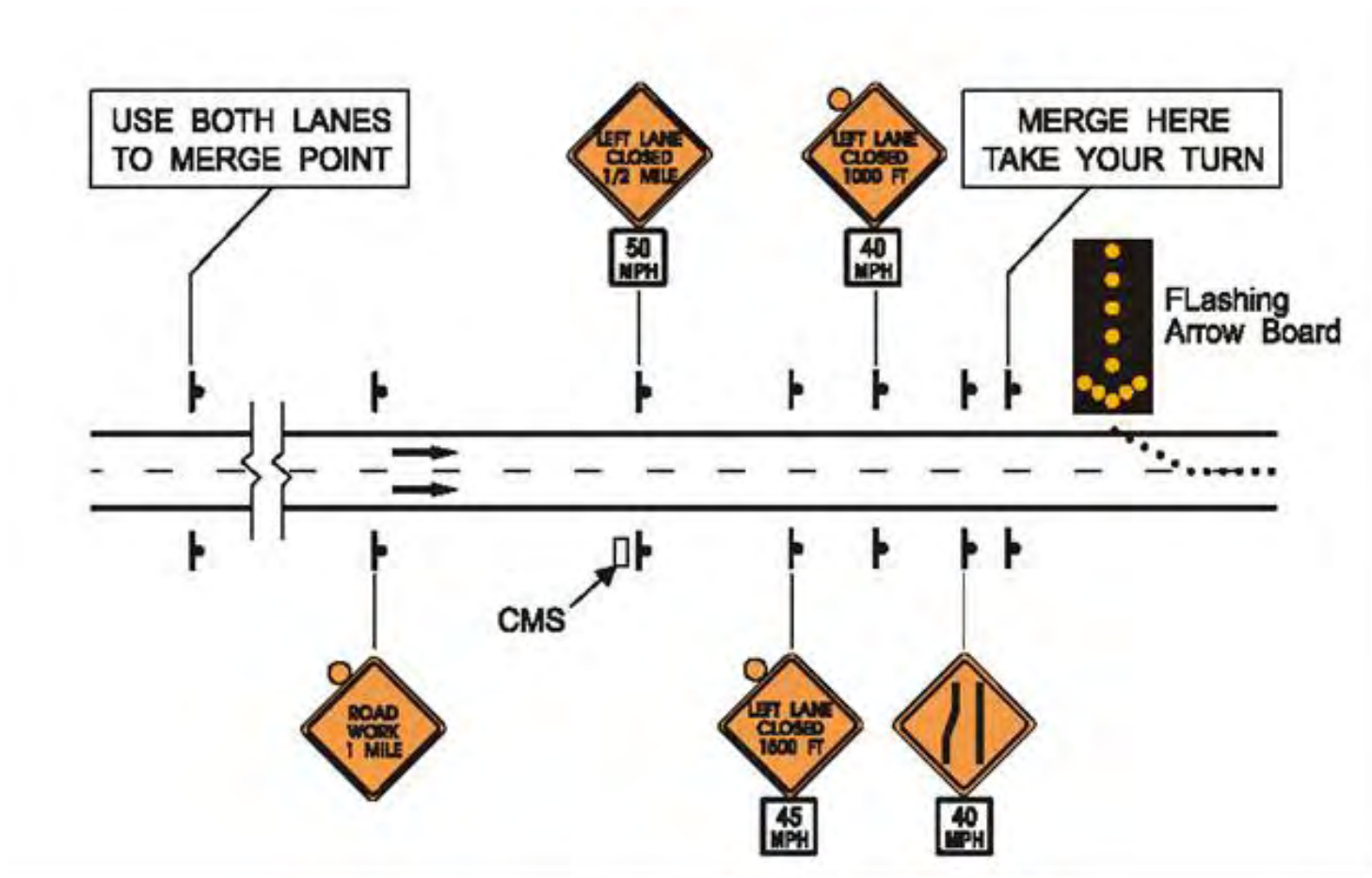
But there was no measurable/observable  
impact on traffic

# Possible Explanations

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- No difference in late merge
  - Site already in static late merge mode
  - Geography: bluff obstructs view of merge pt.
  - Signage: 1<sup>st</sup> right lane closed sign at 1500 ft.
- No change in speed in High Spd. Mode
  - 60 mph speed limit, 2500 ft
  - Ineffective high speed messages?
  - No congestion, good sight distance
  - Relative speeds used for switching

# Explore Static Late Merge?



PennDOT static late merge (Beacher et. al., 2004)

# Other Discussions: Switching Logic

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- Use detectors instead of detector stations?
  - Case 1&1a (late merge mode) only triggered if queue reached CMS2
- Case 1 never occurred, only Case 1a
- High Spd. Mode use absolute vs. relative speeds?
- Change High Spd. Mode messages

# Other Discussions

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- Real-time displays of flow and speed
- MoDOT re-routing reduced congestion
  - Re-routing procedures?
    - Advance warning for re-routing
    - Closure vs. advisory (alternate route)
- Require storage of DMS data
- Coordinated & systematic evaluations

# Descriptions of Video Clips

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- Clip 1 6/25/06 congestion@CMS2 "After"
  - 14:01:29 Hi-sp. Condition went off. Problem w/ hi-sp. switching logic. TD4>>TD1.
  - 14:03:22 Hi-sp. Went back on like it should. Shows both lanes being used even though not in late merge mode. Note lane drop not visible due to bluff.
  - CMS2 FOV: CMS2 1.2mi, road wk ahead 0.7, wk zone 60 mph 0.5, right ln closed 0.3, CMS1 0.2, merge pt. 0.0
  - 14:18:20 late merge mode finally engages. Traffic already stopped when drivers see the "stopped traffic ahead" mssg.
  - 14:26:10 non-usage of discontinuous lane, even though in late merge.
  - 14:27:02 evidence of re-routing, gap in traffic.
  - 14:32:55 non-usage of discontinuous lane, why?
  - 14:33:38 went off late merge mode briefly, then back on, but discontinuous late used again, why?
- Clip 4 7/16 congestion@CMS2 "Before"
  - 16:02:28 note usage of discontinuous lane. Is it because we did the "before" study after the DMS had been on for ~1 month?
  - 16:15:16 clearing of discontinuous lane, why?
- Clip 5 7/16 congestion@CMS1 "Before"
  - 15:58:55 Case of queue jumping (dark SUV) discontinuous lane not used
- Separate DVD 6/25 congestion@CMS1 "After"
  - 14:06:39 diaper crisis, he he
  - 14:15:39 queue jumping truck
  - 14:18:32 queue jumping after late merge engaged
- Before and After similar at CMS2 and CMS1
- Clip 6 7/16 Diversion. Worker in traffic lane.